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体外仿生大鼠胃和人胃的构建与初步应用的研究

The development and the preliminary application of the in vitro rat/human
stomach

陈利丁

指导教师姓名: 陈晓东 教 授

吴雪娥 助理教授

专 业 名 称: 工业催化

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摘要

体外仿生胃是对人或动物的胃进行仿生模拟的装置，可以作为“前测试”来预测活体实验情况或优化试验条件，完全代替或部分替代活体试验，达到降低成本和时间、提高重复性和准确性的目的，而且没有伦理方面的限制。然而，目前已有的体外仿生胃，局限于模拟胃壁的运动、胃的消化环境以及基础的胃内流体动态行为，而对体外仿生胃是否应该具备真实胃的形态及其内部生理结构的研究仍属空白。因此，本论文从收集活鼠胃的生理资料出发，通过检测动态体外仿生胃装置对胃壁动力及固体食物在其中的体外消化和排空，来对体外仿生胃设计的合理性进行评价，进行了以下方面的研究：

首先，分别制备了具有高弹性的、具有真实胃的形态及其内部生理结构的体外仿生大鼠胃和体外仿生人胃，能在体外仿生器械的作用下模拟胃壁的收缩运动。同时制备了单向瓣膜，以保证胃壁的收缩弹性，并能防止排空食糜倒灌。

其次，由于真实胃的形态不规则，导致用仅有真实胃的外部形态的体外仿生大鼠胃进行体外消化实验时，消化曲线的重复性较差。而同时具备真实胃的形态和内部生理结构的体外仿生鼠胃，其体外消化实验的重复性则不会被不规则的外部形态所影响。

不论是用动态体外仿生大鼠胃系统（DIVRS）还是用拉绳牵引的体外仿生人胃系统（RDIVHS）进行体外消化，食糜的排空规律与体内实验的结果具有一致性，这是目前其他体外仿生胃都做不到的，证明了真实胃的外部形态和内部结构对固液混合食物的消化和排空具有重要的影响。然而，DIVRS 和 RDIVHS 的动力部分都不够强劲，特别是对胃壁蠕动和幽门自主开闭模拟的缺乏，导致固体食物在二者内消化率都较低。

关键词：体外仿生胃；单向瓣膜；褶皱；体外消化；拉绳牵引收缩；动态压缩

Abstract

In vitro stomach models are used to simulate the behaviors of human or animals' stomachs, and they can be used to predict or optimize the *in vivo* experiments due to their advantages of saving time, low cost, improved repeatability, and no ethics restrictions. The present in vitro stomach models mainly focused on simulating contractions of the gastric wall, digestive environment and basal gastric fluid mechanics. However, these models failed to simulate the morphology and inner structure of real stomachs. Therefore, the *in vivo* physiology data from the stomachs of live rats were collected for referencing. The main results can be summarized as follows.

Firstly, an in vitro rat stomach model and an in vitro human stomach model, with the morphology and inner structure of the real stomachs, were established by elastic silicone. The in vitro stomach models were able to simulate the contractions on the gastric wall. One-direction valves were also made to control the pressure in the in vitro stomach models and to prevent emptied digesta flowing backward.

Secondly, the repeatability of the in vitro tests was poor without inner structure. If the in vitro rat stomach model has the same morphology and inner structural with the real stomachs, the repeatability of in vitro tests will not be affected by irregular morphology.

Two in vitro stomach models, Dynamic In Vitro Rat Stomach (DIVRS) and Rope Driven In Vitro Human Stomach (RDIVHS), were established to simulate digestion of the solid food. The gastric emptying pattern of the digesta in both stomach models are more similar to the *in vivo* results than other in vitro stomach models. However, DIVRS and RDIVHS failed to simulate the peristalsis of the gastric wall and the autonomously contractions of the pylorus, leading to low digestive efficiency.

Keywords: In Vitro Stomach; One-direction Valve; Wrinkles; In Vitro digestion; Rope Driven Contraction; Dynamic Compression

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